REMARKS

Applicant expresses appreciation to the Examiner for consideration of the subject patent application. This amendment is in response to the Office Action mailed January 13, 2005. Claims 17 and 24 were objected to. Claims 17-34 were rejected. The claims have been amended to address the concerns raised by the Examiner.

Claims 1-34 were originally presented. Claims 1-16 were previously withdrawn from consideration. Claims 1-16 have been cancelled. Claims 17-34 remain in the application. Claims 17, 24, 25, 31, 32, and 34 have been amended. No claims have been added. Claims 17 and 24 were objected to for typographical errors. These errors have been corrected. Claim 17 was amended to include the language "low temperature curing sealant", as disclosed in the specification on page 5, line 19. Claims 24, 25, 31, and 32 have been amended to update dependencies from amended claim 17. Independent claim 34 has been amended to be similar to independent claim 17. Claim 31 was also amended to include language that the sealant can cure at a temperature of less than 100 degrees, as disclosed in the specification on page 5, lines 15-20.

Claim Rejections - 35 U.S.C. § 102

Claims 17-34 (including independent claims 17 and 34) were rejected under 35 U.S.C. § 102(b) as being anticipated by Shiga (USPN 5,723,904) (hereinafter "Shiga").

In order to most succinctly explain why the claims presented herein are allowable, Applicant will direct the following remarks primarily to independent claim 17, as amended, with the understanding that once an independent claim is allowable, all claims depending therefrom are allowable.

The present invention discloses a system and method for hermetically sealing a micro-electro-mechanical system (MEMS) within a MEMS package. Physical limitations of MEMS devices can limit the types of methods used to seal a MEMS package. Hermetic sealing in prior art devices is typically accomplished by sealing a package with solder. The solder and package may be heated momentarily to several thousand degrees, causing a device within the package to be heated to several hundred degrees.

If a MEMS device is heated to the temperatures used in prior art methods for hermetic sealing, it can cause multiple materials used to construct the potentially delicate mechanical devices within a MEMS device to expand at different rates, placing thermal stress on the device and possibly cracking some materials, especially moving parts, located within the MEMS device. (See Chen Background).

The Shiga reference fails to disclose a system or method for hermetic sealing of a MEMS package which does not require the use of melted solder for hermetic sealing. Rather, Shiga discloses a packaged semiconductor device having an electrically conductive cap. The cap is electrically connected to the semiconductor device by applying sufficient heat and pressure to the package and device to enable molten electrically conductive solder to flow through via holes and form a connection between the semiconductor device and the cap (first and second lid members). (See Shiga, Col. 5, Lines 21-33). Heating solder to a molten state typically requires a temperature of 250 degrees Celsius to well over 600 degrees Celsius, depending upon the composition of the electrically conductive solder. For example, Shiga suggests using a gold-tin solder to bond a lid to a sidewall. Gold-tin solder (80/20) melts at a temperature of 280 degrees Celsius. (See attachment)

In Contrast, independent claim 17, as amended, sets forth, in part:

> **at least one low temperature curing sealant placed within the fill port** wherein the at least one low temperature sealant substantially fills the fill port; and
>
> **a metal cap placed over the at least one low temperature curing sealant** in a specific pattern wherein the metal cap substantially hermetically seals the fill port.

Applying high temperatures to the MEMS package and device can cause failure of the MEMS device and adversely affect any media injected into the MEMS package. Therefore, low

temperature curing sealants are desirable to plug the fill port. Sealants which can cure at a temperature below 100 degrees Celsius are typically used. (See Chen, Page 5, Lines 6-23).

Due to the nature of low temperature curing sealants, the MEMS package is typically not hermetically sealed after the sealant has been placed in the fill port. Therefore, a metal cap is placed over the low temperature curing sealant(s) in a specific pattern to form a hermetic seal. A low temperature process can be used to apply the metal cap, such as electron beam deposition and physical vapor deposition. (See Chen, Page 5, Line 24 to Page 6 Line 7). Placing the metal cap over the sealant using a low temperature process can substantially reduce the chance of causing thermal stress to the MEMS device. By placing the metal cap in a specific pattern, rather than using a substantially package sized metal plate, the size and weight of the package is reduced.

The method disclosed in Shiga of flowing molten solder through a via hole would likely cause damage to the MEMS device in the present invention. The present invention enables a MEMS device to be packaged without the use of molten solder, which could cause thermal stress to the MEMS device. Further, Shiga does not disclose a metal cap formed **in a specific pattern** over the sealant. Rather, the metal cap 42 shown in Shiga (FIG. 2) is a substantially package sized metal plate soldered to the package. The plate is not formed in a specific pattern. The plate adds unnecessary weight and size to the package. Further, the soldering taught in Shiga would likely cause excessive thermal stress in a MEMS device.

Therefore, Applicant respectfully submits that claim 17 is allowable, and urges the Examiner to withdraw the rejection.

Regarding claim 18, the Office Action states that Shiga discloses a MEMS device placed within the MEMS package. However, Shiga never discloses the use of a MEMS device. Rather, the device placed within the package in Shiga is an integrated circuit (IC) chip. (See Shiga Col. 1, Lines 9-13). A MEMS device is defined in Wikipedia.com (http://en.wikipedia.org/wiki/MEMS) as a device having mechanical components on the micrometer scale. The micrometer scale can be from several hundred micrometers to less than thousandths of a micrometer. A MEMS device can also include mechanical components on the nanometer scale, having a major dimension from several hundred nanometers in size to less than one nanometer in size.

Unlike a MEMS device, an integrated circuit does not typically have any moving parts. Thus, the IC chip package disclosed in Shiga is able to use flip-chip bonding. In contrast, the present invention uses low temperature curing sealants and metal cap deposition processes in order to minimize thermal stress on the mechanical portions of the MEMS device disclosed in claim 18.

Regarding claims 19 and 20, the Office action states that FIG. 2 of Shiga discloses a bond ring wherein the fill port is located in a break in the bond ring. However, Shiga does not disclose the use of a bond ring in the semiconductor package. Nor does Shiga disclose a break in the bond ring for use as a fill port.

Regarding claims 21-23, the Office action states that Shiga discloses a lid wherein the fill port is a through-hole located in the lid, and wherein the lid is selected from the group of materials consisting of glass and silicon. In contrast, the lid disclosed in Shiga is an electrically

conductive cap. (See Shiga, Independent Claims 1, 2, and 4). Neither glass nor silicon is electrically conductive. Therefore, a glass or silicon lid could not be used in Shiga.

Regarding claims 24 and 25, Shiga does not disclose the use of organic or inorganic sealants. Further, none of the listed sealants in the claim, including thermal-set epoxy, UV curable epoxy, two-part epoxy, or spin-on polyamides are disclosed in Shiga. Shiga merely discloses the use of molten electrically conductive solder to hermetically seal a chip package.

Regarding claims 26 – 30, Shiga does not disclose the use of a medium to be inserted into the semiconductor package. Therefore, no gasses, liquids, or solids are disclosed as media used to fill the package.

Regarding claim 31, Shiga does not disclose a sealant which uses a curing process. Therefore, no low temperature curing process is disclosed. Shiga merely discloses the use of molten electrically conductive solder to hermetically seal a chip package.

Regarding claims 32 and 33, Shiga does not disclose the formation of a metal cap using a low temperature process such as electron beam deposition and physical vapor deposition. Shiga merely discloses the use of an electrically conductive cap which is bonded to a side wall using solder. (See Shiga Col. 5, Lines 21-33).

Therefore, applicant respectfully submits that claims 18-33 are allowable, and urges the Examiner to withdraw the rejection. Further, rejection of the dependent claims 18-33 should be reconsidered and withdrawn for at least the reasons given above with respect to the independent claim. The dependent claims, being narrower in scope, are allowable for at least the reasons for which the independent claim is allowable.

Regarding claim 34, the same arguments stated above for claim 1 apply for amended claim 34. Amended claim 34 sets forth, in part:

> **a means for filling a MEMS package through a fill port** with at least one medium;
>
> **a means for plugging the fill port in the MEMS package with at least one low temperature curing sealant;**

As discussed above, Shiga does not disclose a means for filling a MEMS package with any media. Further, Shiga only discloses plugging a through hole with electrically conductive molten solder. Molten solder is not a low temperature curing sealant.

Therefore, applicant respectfully submits that claim 34 is allowable, and urges the Examiner to withdraw the rejection.

CONCLUSION

In light of the above, Applicant respectfully submits that pending claims 17-34 are now in condition for allowance. Therefore, Applicant requests that the rejections and objections be withdrawn, and that the claims be allowed and passed to issue. If any impediment to the allowance of these claims remains after entry of this Amendment, the Examiner is strongly encouraged to call Steve Perry at (801) 566-6633 so that such matters may be resolved as expeditiously as possible.

No claims were added. Therefore, no additional fee is due.

The Commissioner is hereby authorized to charge any additional fee or to credit any overpayment in connection with this Amendment to Deposit Account No. 08-2025.

DATED this 10th day of March, 2005.

Respectfully submitted,

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Product Bulletin

Eutectic Gold/Tin Solder

Eutectic Gold/Tin Solder is used in a number of specialty joining applications where combinations of the alloy's strength, thermal conductivity, corrosion resistance and compatibility with precious metals answers the engineering design needs.

Applications

- **Microwave Systems**

AuSn is extensively used in microwave systems assembly. Long term joint reliability is provided, together with compatibility with gold metallization.

- **Lid Sealing**

AuSn solders provide hermiticity at relatively low bonding temperatures.

- **Die Attach**

AuSn is an effective die attach solder where thermal considerations eliminate higher melting gold-based systems.

- **High Strength Joints**

When high joint strengths are demanded, eutectic AuSn is a non-braze alternative.

Availability

Cookson Electronics' eutectic AuSn is sold as wire, foil, preform or as solder paste.

- **Engineered Products**

Precision extruded wire or rolled foils are available. Preforms can also be fabricated to customer designs. Preforms both facilitate solder operations and control the volume of material used.

- **Solder Paste**

Paste is supplied using Type 2 (minus 200 mesh) and Type 3 (minus 325 mesh) powder depending on the application. Type 2 is recommended for processes using 80 - 100 mesh screens while Type 3 is preferred for 165 - 180 screens. Dispense applications require Type 3 powder.

Metal content is controlled to ±1% of the design composition within the range 60 - 90 weight %.

Paste viscosity can be varied to meet the needs of the placement method and held to ± 10% lot to lot.

Excellent wetting can be achieved with AuSn paste using a number of fluxes. R and RMA fluxes meeting MIL-F-14256, J-STD-004 and J-STD-005 standards are available as are low residue and other proprietary chemistries.

Refrigerated (2 - 5°C) shelf life is approximately six months. Ambient temperature use is recommended.

Eutectic AuSn Properties

Composition (wt%)	80Au 20Sn
Melting Point	280°C
Density	14.7 g. cm^{-3}
Coefficient of Thermal Expansion (20 - 250 °C)	16 x 10^{-6} °C
Thermal Conductivity	58 $Wm^{-1}K^{-1}$

Mechanical Properties (20°C)

Tensile Strength	275 MPa
Young's Modulus	68 GPa
Shear Modulus	25 GPa
Poisson's Ratio	0.405
Lap Shear, Joint Strength	50 MPa

Cookson Electronics ASSEMBLY MATERIALS

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